National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 9786 (DSI-9786)

Parameterized Atlantic, Pacific and Mediterranean Grid Points Spectral Ocean Wave Model (SOWM), Hindcast Wind and Wave Climatology

December 31, 2002

National Climatic Data Center
151 Patton Ave.
Asheville, NC 28801-5001 USA

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1. **Abstract**: In December 1974 the Fleet Numerical Oceanography Center FLENUMOCEANCEN in conjunction with the Naval Oceanographic Office (NAVOCEANO) adopted the Spectral Ocean Wave Model (SOWM) developed by Dr. Willard J. Pierson and others to produce the operational spectral wave data for the Northern Hemisphere. The SOWM is a computer-based procedure that produces a directional variance spectrum at specified grid points spaced at up to 180 nautical mile intervals. This spectrum defines the sea surface at each grid point through a two-dimensional (direction/frequency) matrix of 12 directions and 15 frequency bands. Further information on the theoretical basis of the SOWM is contained in Appendix A.

At the Seakeeping Workshop in July 1995, the rationale and structure of a hindcast wind and wave climatology were developed. It was concluded at that time that the hindcast climatology be intended to provide a statistical basis for evaluating the effects of the environment.

In order to summarize a set of spectra, it is often useful to generalize the most significant characteristics. The David Taylor Naval Ship Research and Development Center (DTNSRDC), with Operations Research, Inc. (ORI), developed computer programs to derive a number of numerical parameters from the spectral wave data. The National Climatic Data Center (NCDC) used many of the concepts from these programs and others written by FLENUMOCEANCEN to devise a parameterization routine that was used for this atlas.

OVERVIEW: This atlas contains climatological summaries for seven parameters. Four of these parameters have already been summarized in other climatic atlases (U.S. Navy, 1974 and 1987). These include wind speed and direction, significant wave height (hereafter referred to as the wave height), and wave direction, i.e., the direction from which the highest waves are moving (hereafter referred to as primary wave direction). The other three parameters contained in the wave climate summaries for this atlas are: wave slope parameter, modal wave period, and directionality of the waves (hereafter referred to as the directionality). These three parameters have not appeared in previous U.S. Navy climatological atlases, because they cannot be directly derived from visual observations. However, they can be very important operating considerations. Appendix B provides a complete description of all seven parameters. A brief description of the wave slope parameter, modal wave period, and directionality follows.

The wave slope of a regular wave is defined as the ratio of wave height to wave length. It is not normally reported, but it can be obtained from the output of the SOWM or from the frequency spectrum of a wave record. Ship rolling and hence stability is affected by the wave slopes of the higher waves encountered. The wave slope parameter is directly related to the wave slope. Therefore, the higher the wave slope parameter, the higher the wave slope. Table B3 in Appendix B relates the wave slope parameter to values of the wave slope at a fixed point. Steep waves are usually associated with wave slope parameters of 0.10 or more, while values of less than 0.05 are usually associated with more moderate conditions.

The modal wave period is defined in terms of the frequency spectrum. It is the period associated with the maximum wave energy in the wave spectrum. Modal wave periods associated with wave lengths about 0.75 and 1.25 ship lengths (depending on ship course and speed) can cause resonance pitching and heaving. The modal wave period is not necessarily equal to the wave period associated with the higher of the two waves, the sea or the swell as

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summarized in the past U.S. Navy climatologies (U.S. Navy, 1974).

The directionality is a measure of the uniformity of the direction of movement of the waves. If the waves are all moving in a uniform direction then the directionality is equal to one. When there is no preferred direction of wave movement (a completely confused sea state) the directionality takes on the value of 0. Obviously, ship response and maneuverability can be affected by the directional spread of the wave energy.

Data in this atlas are derived using winds and waves from the period January 1973 to December 1982, i.e., 10 years. Computer processing difficulties during the generation of the SOWM hindcast data caused the number of hindcasts to vary among grid points. As a result, approximately 10% of all the data were lost during the 10-year hindcast period, 1973-1982 (Steurer, 1988).

Isopleth analyses were completed for various thresholds for the percent frequency of wind speed, wave height, and the wave slope parameter. These analyses were based on nearly 220 grid points, 63 of which are also used in tabular presentations. All points are depicted on the Mediterranean Sea map (Fig. 1). The 63 grid points also used in tabular summaries are listed in Table 1.

The Mediterranean Sea contains many areas of shallow water (< 100 fathoms) due to the large numbers of peninsulas and island groups. Since SOWM is a general purpose deep-water model, care should be taken when interpreting the analyses for shallow-water applications. The gray line in Figure 1 is in fact the 100 fathom isobath.

Unlike previous SOWM atlases (U.S. Navy, 1983 and 1985), isopleth analyses are shown in areas of less than 100 fathoms. This was done in order to provide more continuous analyses that would be less confusing to the user.

Before 1975, FLENUMOCEANCEN relied on "singular" wave models to predict wind wave, and swell heights as well as their corresponding directions and periods. The basic weakness of the "singular" models is that they do not accurately depict the complex wave propagation in the larger oceans like the Atlantic and pacific where several wave trains can coexist in one area at any given time.

The SOWM is a wave specification and forecasting procedure that will describe the complex frequency-direction spectrum of waves in deep water with a reasonable resolution on a grid of points over the ocean. As originally planned, there were to have been four times as many grid points and twice the angular resolution for the spectra. The computer program exists for this higher resolution model, but it is not operational. running time and memory allocation constraints made it necessary to reduce the number of grid points and decrease the angular resolution. This coarser grid can result in a misinterpretation of sub-grid scale features and fetch.

Since the SOWM is a general purpose deep-water model, it was not designed to include effects such as refraction, diffraction, shoaling, and bottom friction. As a consequence, SOWM output should be interpreted with a great deal of care for shallow water applications. also, there are no wave-wave or wave-current interaction mechanisms; the latter have been observed to alter the wave fields in regions of a strong current like the Aguhlas Current and the Gulf Stream.

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The grid points were laid out on gnomonic subprojections of an icosahedron (a solid whose surface is 20 equilateral triangles) so as to allow great circle propagation. For each of the 20 triangles, a gnomonic projection is used. Thus, a straight line with any orientation on any of the 20 subprojections is a great circle. On the sphere, the sides of the equilateral spherical triangle intersect at an angle of 72 degrees and, thus, five triangles meet at a common point. On a map, the sides of the equilateral triangle meet at an angle of 60 degrees, if each triangle is plotted as a gnomonic projection.

The triangles are not oriented in a simple way relative to the latitudes and longitudes on the Earth. Instead, the icosahedron was located so as to maximize the number of vertices on land. Figure A1 shows the 20 triangles as their vertices and edges appear on a Miller projection[1]. (A Miller projection is a cylindrical projection similar to a Mercator projection with less exaggerated spacing of the parallels at high latitudes). Each triangle covers exactly the same area, and the marked distortion of a Miller projection is evident.

Two sides of a triangle form a natural set of axes for each subprojection and the grid of points at which the SOWM spectra are computed are formed by the intersections of equally spaced lines drawn parallel to the two chosen sides of each subprojection as shown in Figure A2. Each grid point, in principle, should be representative of wave spectra anywhere within the hexagon surrounding the grid point.

The great circle property is indicated by the fact that waves can travel to a given grid point along a great circle path from any one of the six surrounding grid points, thus accounting for six of the 12 direction bands in the model. The other six direction bands have directions of travel halfway between those for each of the primary directions. These spectral components are effectively treated as if they come from a source on the inner hexagon surrounding each grid point at a point halfway between two grid points. The distance involved is thus only about 85% of the primary distance as shown in Figure A3. Land boundaries and a prescribed ice limit act as sinks for spectral components. Grid points just south of the equator are treated as an artificial land boundary to provide appropriate sinks for southward moving spectral components and artificially fetch limited waves for southerly winds at the equator. No swell from the Southern Hemisphere exists in the model, although they could be appreciable just north of the equator during the Southern Hemisphere winter. Also, there is no specific provision for tropical cyclones in the model.

Once the grid, the spectral resolution, and the time step are prescribed, the model can compute what the spectrum will be at each grid point x hours later, given an initial wave spectrum and the winds at all grid points at the time, $t = t_0$.

In the SOWM, this is accomplished by computing: (1) how much the wind-generated sea will increase or grow (if at all) during the next time step at each grid point; (2) how much the waves traveling against the wind (+/- 90^0) will be dissipated;(3) how far each spectral component will propagate at a representative group velocity along a great circle path in x hours; and, then reassembling the spectra for the end of the time step.

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For brevity, these steps are called Grow, Dissipate, and Propagate. For the SOWM hindcasts at the end of a six-hour time step, within the resolution of the model, the new spectra at the grid points represented the waves at t = t + 6 hours; new winds were then used, and the processes of Grow, Dissipate, and Propagate were repeated.

Table 1
Directional Variance Spectrum
Wind direction = 160? Wind Speed = 21.5 knots
Central Frequency (Hz)

Direction (degree)	.308	.208	.158	.133	.117	.103.	092	.081	.072	.067	.056	.050	.044	.039	Directional Total
96.6															
66.6															
36.6															
6.6															
336.6															
306.6															
276.6				.01	.06	.10	.15	.42	.15	.02	.02				.93
246.6	.04	.12	.18	.13	.13	.11	.05	.03	.01		.01				.82
216.6	.06	.20	.35	.29	.33	.18	.06	.02							1.49
186.6	.06	.20	.37	.30	.28	.01	.09	.02							1.33
156.6	.04	.14	.20	.14	.12	.01	.03	.01							.69
126.6	.03	.08		.04	.03										.18
Point Total Spectrum	.23	.75	1.10	.91	.75	.41	.38	.50	.16	.02	.03				5.44
															(ft^2)

Derived parameters:
H_{mo} = 9.3 ft
T_p = 6.32 s
? = 0.085
PWD = 212?
$?_c$ = 0.77

Table 2

Band Number	Band Width x 180	Central Frequency	Central Frequency	Period	Lower Bound x 180	Upper Bound x 180
1	24	55.5/180	0.30833	3.24	43.5	67.5
2	12	37.5/180	0.20833	4.8	31.5	43.5
3	6	28.5/180	0.15833	6.32	25.5	31.5
4	3	24.0/180	0.13333	7.5	22.5	25.5
5	3	21.0/180	0.11666	8.57	19.5	22.5
6	2	18.5/180	0.10277	9.73	17.5	19.5
7	2	16.5/180	0.09166	10.91	15.5	17.5
8	2	14.5/180	0.08055	12.4	13.5	15.5
9	1	13.0/180	0.07222	13.85	12.5	13.5
10	1	12.0/180	0.06666	15.0	11.5	12.5
11	1	11.0/180	0.06111	16.4	10.5	11.5
12	1	10.0/180	0.05555	18.0	9.5	10.5
13	1	9.0/180	0.05000	20.0	8.5	9.5
14	1	8.0/180	0.04444	22.5	7.5	8.5
15	1	7.0/180	0.03888	25.7	6.5	7.5

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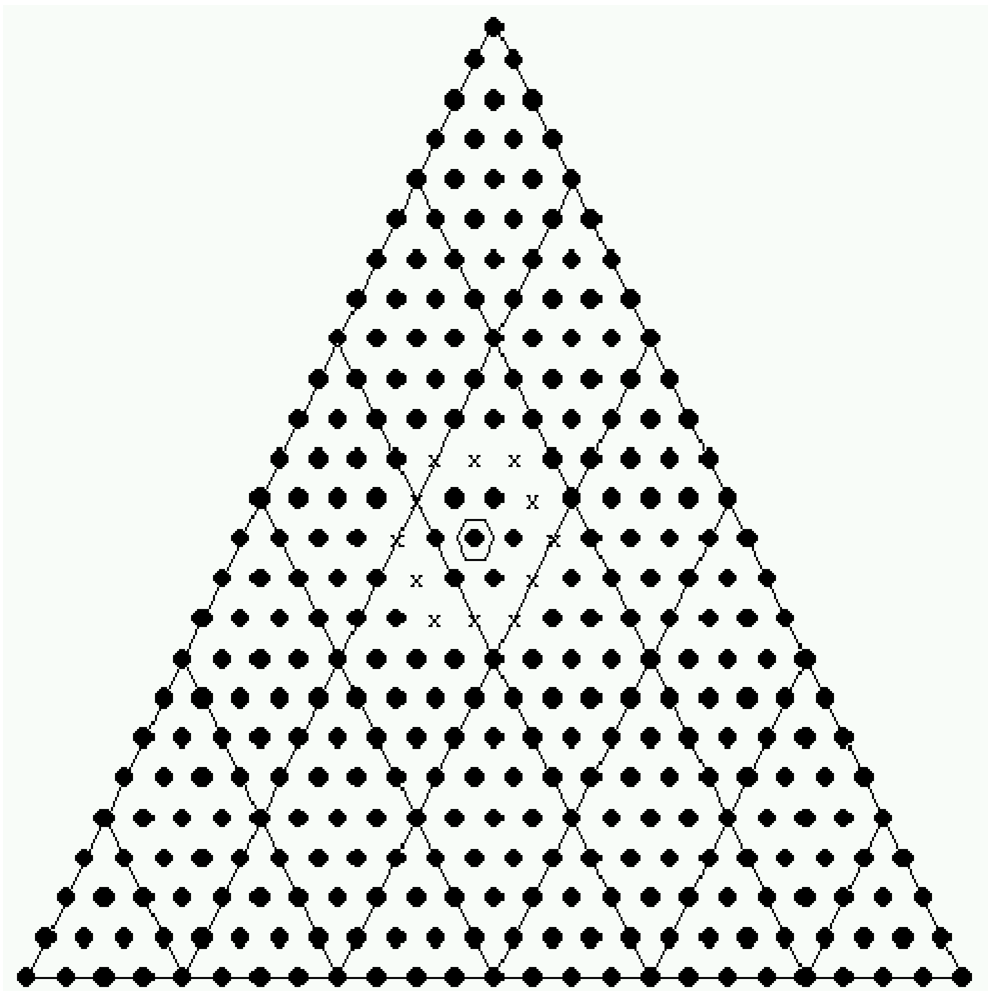
Table 3

Wave Slope Parameter (□)	Ratio Wave Length (L) to Wave Height (H)	Angle of Wave Slope $\tan^{-1}$ (H/L)
0.01	222.0	0.3 degrees
0.02	111.0	0.5 "
0.03	74.0	0.8 "
0.04	55.5	1.0 "
0.05	44.4	1.3 "
0.06	37.0	1.5 "
0.08	27.8	2.1 "
0.10	22.2	2.6 "
0.11	20.2	2.8 "
0.12	18.5	3.1 "
0.13	17.1	3.3 "
0.14	15.9	3.6 "
0.15	14.8	3.9 "



The 325 grid points on a triangular gnomonic subprojection for the SOWM. Any
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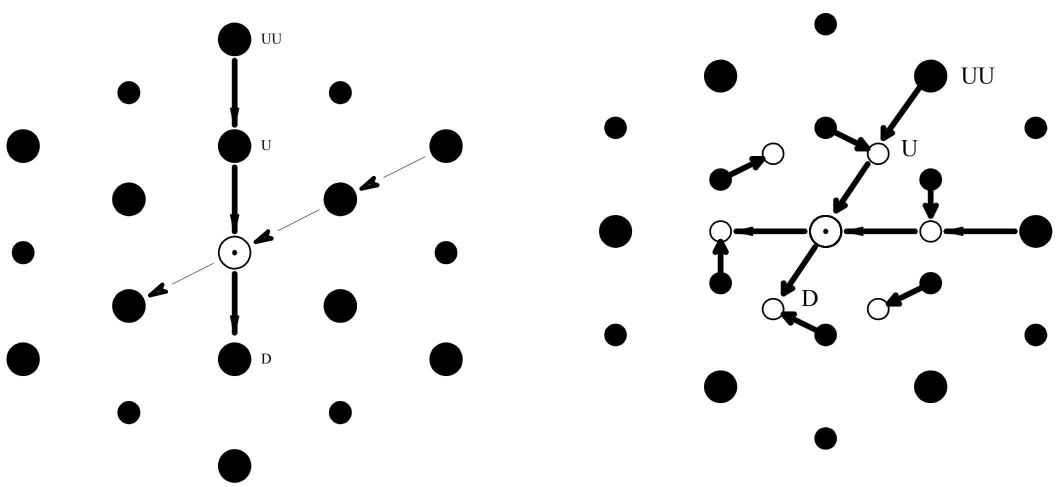
straight line is a great circle. The hexagon around the circled dot shows the area represented by a grid point. The inner hexagon of heavy dots and the outer hexagon of X's show those grid points required to treat wave propagation effects at the circled point. (After Pierson, 1982)

Six Primary Directions   Six Secondary Directions



Grid points involved in propagation. The large dots on the left are for the six primary directions. For the circled point a downward propagating spectral component requiring an upstream point, an upper upstream point and a downstream point are shown. for secondary directions, the points on the inner hexagon are treated as if located at the open circles - for one time step. The shift is reversed for the next time step. (After Pierson, 1982)

2. <u>Element Names and Definitions</u>:

BAS: Basin
SP: Subprojection
GP: Grid point
YR: Year
MO: Month
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DA: Day
HR: Hour
LAT: Latitude * 10

LON: Longitude * 10

WIND DIR: Wind direction in degrees

WIND SPD: Wind speed in knots

$H_{1/3}$: Significant wave height in feet

WVSLPE: Wave Slope

V_i : the variance associated with the ith frequency(cell value)

W_i : the ith frequency band (central frequency).

PRI WVDIR: Primary wave direction

SEC WVDIR: Secondary wave direction. Must have at least 4% of the energy of the primary and be greater than the 0.1 ft2. (0. implies no secondary)

T_{pp}: Peak period in the direction of the primary wave direction. Period associated with the maximum variance in the direction of the primary wave direction.

T_p: Peak Period. Period associated with the peak variance density.

T_z: Mean zero upcrossing period. A wave period is the time of one complete cycle of a sinusoidal wave generally measured from crest to crest or trough to trough. The zero upcrossing period is time measured from the zero level (mean sea height) between the trough and crest as the wave approaches the crest from the trough until it starts to repeat the cycle at the zero level. The zero upcrossing period (T_z) or zero downcrossing period can be considered an average value, while the peak period (T_p) represents the period of the waves with greatest energy.

$$T_z = 2\pi(m_0 / m_2)^{1/2} \quad \text{where} \quad m_0 = \sum_{i=1}^{k} V_i \quad \text{and} \quad m_2 = \sum_{i=1}^{k} V_i \varpi_i^2$$

k = number of frequency bands

V_c = variance associated with the ith frequency (energy variance - cell value)

W_i = central frequency ith frequency band

M^2 = spreading parameter, it varies from 0 to 1 and is a measure of the angular spread of the directional wave energy about the mean direction.

$$M^2 = 1/m_o \sum_{i=1}^{12} V_d \sin^2(\theta_i - \theta_c) \quad \text{where} \quad \theta_c = \tan^{-1}(e_x/e_y) \text{ and}$$

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where $V_d = \sum_{i=1}^{15} V_i$ for a given j (one of the 12 directions - directional spectrum totals)

θ_i = direction associated with the variance in the directional spectrum totals

999: Code implies missing data.

The output from a SOWM hindcast includes a directional variance spectrum at each grid point as represented by 12 equally divided direction bands and 15 frequency bands of varying widths as depicted in Tables 1 and 2. The direction bands are unique for each grid point, but the frequency bands remain constant for all grid points(Table 2). The lowest possible frequency in a SOWM spectrum is 0.0388 Hz which corresponds to a period of 25.7 seconds. Conversely, the highest frequency is 0.308 Hz which corresponds to a period of 3.24 seconds. The SOWM generates 'energy variances' in each cell within the 180 element matrix from input wind fields. There is a certain amount of confusion inherent in the terminology 'energy variances' since the values within each cell are not energies. It is necessary to digress somewhat to appreciate the roots of this terminology.

In a steady Sea State the record of the waves (a continuous time series of the rise and fall of the sea surface at a point) does not repeat itself exactly from one wave to the next because the waves are a superposition of sinusoids with many different frequencies and directions of travel. Every wave record of finite length as a function of time, however, can be decomposed into harmonics. The zeroth harmonic is the mean elevation of the sea and is assumed to be zero for the analysis since the contributions from much longer periods such as the tides are constants during the time of observation. The first harmonic, is a least squares fit of a sinusoid with a period equal to the wave record with its peak positioned such that its amplitude is maximized. The first harmonic has one maximum and minimum for the entire wave record. The second harmonic has a period of one-half the wave record with its two peaks positioned such that it too has maximum amplitude. Each subsequent harmonic can be thought of as a least squares fit of a sinusoid with the number of peaks and valleys (or the period) increasing (decreasing) corresponding to the harmonic number. By adding each new harmonic to the preceding harmonics, the harmonics or the 'Fourier Series' begin to resemble the wave record. If the number of observations on the wave record is N, the N/2 harmonics will completely describe the wave record.

The average energy in the wave motion per unit area is described by:

$$E = \text{‰}\rho g\, a^2 \qquad (1)$$

where ρ is the density of the ocean water, g is the acceleration of gravity, and a is the wave amplitude. Half of the energy is kinetic, and the other half is potential.

Recalling that each wave record can be decomposed into a number of harmonics, then if the amplitude of each harmonic is squared, multiplied by ($\frac{1}{2}\rho g$), and plotted on a graph as the ordinate using the associated frequency or period of the harmonic as the abscissa, the resulting graph is a 'wave energy spectrum.' Initially it was customary to present the spectrum in this manner (World

Meteorological Organization, 1976), but since the magnitude of the right-hand side of Eq. 1 is dominated by (a^2) the multiplication of (ρg) is now omitted. This is the format of the data generated in the SOWM hindcasts. Each cell in Table 1 can be summed to yield the quantity ($\frac{1}{2} a^2$). The omission of the ρg transforms the 'wave energy spectrum' into an 'energy variance spectrum' or more appropriately 'variance spectrum', since the sum of each cell in Table 1 will equal the variance of the spectrum of the wave record it is representing. Likewise, the area under a variance spectrum curve as derived from the frequency spectrum totals in Table 1 will equal the variance of the spectrum represented.

WAVE HEIGHT

In Table 1 each quantity within the cells of the table has units of ft^2, and cells without any values contain component variances less than 0.01 ft^2. Such small values were considered insignificant, and were not retained in the output generated from the SOWM hindcast. The total variance of each spectrum can be converted to a spectral wave height parameter (H_{mo}) which closely corresponds to the significant wave height ($H_{1/3}$). The significant wave heigh on a wave record is defined as the average height of the highest one-third of the wave heights. The quantity ($H_{1/3}$) has been shown to roughly approximate the characteristic wave height observed visually (Cartwright, 1964; Nordenstrom, 1969). The spectral wave height parameter (H_{mo}) from Rayleigh statistics is defined as: $H_{m_o} = 4(m_o)^{1/2}$ (2)

where m_o is the sum of the component variances (V_i) of all cells of Table 1. The quantity (m_o) is commonly referred to as the moment of order zero. The correspondence between H_{mo} and $H_{1/3}$ is strictly valid for a spectrum with most of its energy or variance concentrated over a narrow range of frequencies, but the approximation in the cases with a broader spectrum is sufficiently close for most practical applications (World Meteorological Organization, 1976).

WAVE PERIOD

The choice of the modal or peak wave period (T_p) is based upon the 'variance densities' of the point spectrum. 'Variance densities' with dimension of ft^2-sec are obtained by dividing the variances by the frequency bandwidth. In the SOWM the bandwidths vary in size from 0.00560 to 0.1333 Hz. After dividing by the bandwidth, the energies are standardized with respect to one another. T_p can then be obtained by choosing the central frequency, or corresponding period, associated with the peak variance density. In Table 1, T_p is associated with the central frequency of 0.158 Hz, which equates to a period of 6.32 seconds. The problem associated with an ill-defined modal period of a specific spectrum, as occurs when there is only a small difference between the variance densities of two or more frequency bands, is minimized due to the large number of spectra included in the summaries presented in this atlas.

WAVE SLOPE

The slope associated with very high waves is considered by many ship designers to be a major contribution to operational failures. The wave slope is often estimated using the ratio of the wave height (H) to the wave length (L). However the relationship usually used to obtain wave length:

$L = 5.12T^2$ (3)

where T is the wave period in seconds and L is the wave length in feet is valid only when the wave is a simple periodic sine wave. Pierson (1955) clearly states that Eq. 3 does not hold for the irregular sea surface. The assumptions under which Eq. 3 was derived are violated outside of the wave tank. An alternative method of estimating the wave slope is needed. Since the SOWM provides a frequency spectrum of wave energy this information is used directly in this atlas to calculate a wave slope parameter(□).

The wave slope parameter, □ , is defined by: $$\alpha = \frac{(m_4)^{‰}}{g} \quad (4)$$

where m_4 is the moment of order four (the fourth moment). The moments are defined by:

$$m_n = \sum_{i=1}^{\kappa} V_i \omega_i^n \quad (5)$$

where ω is the circular frequency ($2\pi W_i$; W_i = central frequency of each band width), n is the order of the moment, V_i is a componet variance (individual cell value), and κ is the number of frequency bands. The parameter α is the root mean square of the absolute slope at any fixed point. Cummins and Bales (1980) derived the wave slope parameter α. It should be noted that α is more strongly influenced by the shorter, higher frequency components of the spectrum than by the larger, longer, but not so steep waves near the modal frequency. Thus, a "rough sea" as measured by α, does not necessarily imply a "high sea." Information regarding the significance of its range of values can be calculated from the derivation of the root mean square wave slope of a regular wave.

The resulting equation is (Gentile, 1982): $$\sigma = \frac{\pi}{\sqrt{2}} \frac{H_w}{L_w} \quad (6)$$

where H_w is the wave height (crest to trough) and L_w is the wave length. Information in Table 3 is based upon Eq. 6.

PRIMARY WAVE DIRECTION AND DIRECTIONALITY

The primary wave direction (PWD) and the directionality (□ c) are two parameters which are derived from the directional spectrum totals as opposed to the frequency spectrum totals. The definition of the PWD is taken directly from the FLENUMOCEANCEN's 1981 version of their operational SOWM computer program (Lazanoff, 1981). The PWD is determined by a multi-step process. First, the maximum variance (V_m) in the directional totals is identified, where m is on of the twelve directional bands. Next, the following true-false tests are performed in <u>sequence</u>.

$$V_m > \sqrt{2}[\sum_{d=1}^{12} V_d] d \neq m \quad (7)$$

$$V_{m,m+1} > \sqrt{2}\,[\sum_{d=1}^{12} V_d]\, d \neq m, m+1 \tag{8}$$

$$V_{m,m+1,m-1} > \sqrt{2}\,[\sum_{d=1}^{12} V_d]\, d \neq m, m+1, m-1 \tag{9}$$

where i is one of the 12 directional bands, and V_{m+1} is the higher of the two adjacent directional variances.

If Eq. 7 is true, then the PWD is the direction associated with V_m. If Eq. 7 is false, Eq. 8 is tested; and thusly for Eq. 9. For the first successful test of Eq. 8 or Eq. 9, the vectors defined by the directions and variances of the quantities on the left-hand side of the inequalities are summed and the resultant direction defined as the PWD. If Eq. 9 is false, then the PWD is not defined, and a confused sea state is assumed. The methodology used for defining the PWD is somewhat arbitrary, but the technique has proved quite useful operationally.

The degree of directionality is defined by: $\rho_c = (\rho_x^2 + \rho_y^2)‰$ (10)

where $$\rho_x = (1/m_o)\sum_{i=1}^{12} V_i \sin\theta_i \tag{11}$$

$$\rho_y = (1/m_o)\sum_{i=1}^{12} V_i \cos\theta_i \tag{12}$$

The angle is the direction associated with the variances in the directional spectrum totals (V_d). The directionality has a value of one for an unidirectional sea state, and a value of zero when there is a completely symmetric distribution of a variance around the compass. This parameter has the same properties as the 'constancy' parameter, often used in climatological wind summaries.

B													
A		**Wind**	**WV**		**PriWV**	**SecWV**							
S	**SPGPYrMoDaHr**	**Lat Lon**	**Dir**	**Spd**	**$H_{1/3}$**	**SLPE**	**DIR**	**Dir**	**T_{pp}**	**T_p**	**T_z**	**r_c**	**M^2**
1:1	303264090103	483-1779	215.	13.7	4.5	.066	274.9	203.5	7.50	7.50	5.10	.75	.35
2:1	303264090109	483-1779	202.	15.2	4.7	.071	.0	.0	.00	6.32	4.93	.75	.38
3:1	303264090115	483-1779	197.	15.3	4.8	.070	201.8	263.5	6.32	6.32	4.96	.78	.35
4:1	303264090121	483-1779	180.	13.1	4.0	.064	198.7	.0	6.32	6.32	4.75	.78	.32
5:1	303264090203	483-1779	169.	12.6	3.5	.060	175.7	.0	6.32	6.32	4.57	.77	.33
6:1	303264090209	483-1779	156.	17.1	4.8	.072	164.6	113.5	6.32	7.5	4.86	.82	.28
7:1	303264090215	483-1779	132.	25.9	8.1	.084	104.4	173.5	8.57	8.57	6.00	.78	.35

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8:1	303264090221	483-1779	124.	36.6	10.9	.097	106.6	173.5	8.57	8.57	6.65	.72	.41
9:1	303264090303	483-1779	132.	36.4	16.0	.103	112.9	173.5	10.91	10.91	8.12	.79	.34
10:1	303264090309	483-1779	151.	25.8	15.8	.100	102.9	173.5	10.91	10.91	8.16	.75	.41
11:1	303264090315	483-1779	204.	12.1	13.4	.082	183.6	113.5	10.91	10.91	8.41	.76	.33
12:1	303264090321	483-1779	265.	22.5	15.6	.096	.0	.0	.00	10.91	8.13	.56	.47
13:1	303264090403	483-1179	269.	19.2	4.2	.092	292.4	203.5	10.91	10.91	8.00	.73	.34

NOTE: In the above example printout, notice that line 12 is a good example of a confused sea state.

3. Start Date: 19720101

4. Stop Date: 19821231

5. Coverage: North Atlantic, Northern Pacific, and Mediterranean Sea Grid Points

File Number	Grid Point	Latitude	Longitude
1	006	43.9N	08.9E
2	019	43.3N	15.3E
3	022	42.3N	04.5E
4	024	42.5N	06.3E
5	036	41.6N	03.7E
6	041	41.9N	08.1E
7	042	42.0N	09.9E
8	055	41.1N	05.5E
9	069	40.1N	01.2E
10	072	40.3N	03.8E
11	080	40.7N	11.7E
12	084	40.6N	18.8E
13	087	40.1N	24.9E
14	091	39.5N	02.2E
15	094	39.8N	05.7E
16	096	39.8N	07.4E
17	129	39.3N	15.2E
18	130	39.3N	17.8E
19	139	38.0N	00.7E
20	143	38.3N	04.1E
21	147	38.5N	07.5E
22	149	38.6N	09.2E
23	151	38.6N	10.9E
24	153	38.7N	12.6E
25	159	38.6N	18.6E
26	163	38.1N	25.4E

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27	172	37.4N	01.7E
28	199	36.0N	35.2E
29	201	36.0N	04.0W
30	205	36.5N	00.7W
31	213	37.1N	05.9E
32	220	37.3N	11.8E
33	233	36.6N	26.9E
34	235	36.4N	28.5E
35	239	35.9N	31.8E
36	247	35.6N	02.2W
37	259	36.5N	19.3E
38	263	36.3N	22.6E
39	265	36.2N	24.3E
40	267	36.0N	25.9E
41	273	35.3N	30.8E
42	277	34.7N	34.8E
43	282	36.0N	13.5E
44	286	35.9N	16.8E
45	295	35.2N	26.6E
46	297	35.0N	28.3E
47	316	35.2N	19.2E
48	318	35.1N	20.8E
49	322	34.8N	24.1E
50	330	34.0N	30.5E
51	334	33.5N	33.6E
52	358	33.7N	28.0E
53	362	33.3N	31.1E
54	370	34.0N	12.7E
55	374	34.0N	15.9E
56	382	33.6N	22.3E
57	406	33.2N	18.3E
58	408	33.1N	19.9E
59	416	32.6N	26.2E
60	420	32.2N	29.3E
61	424	31.7N	32.4E
62	428	32.6N	15.9E
63	452	31.2N	18.9E

Parameterized North Pacific Grid Points

Seq. Number	Grid Point Subprojection	Latitude	Longitude
1	176-3	64.0N	166.7W

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2	140-3	59.4N	172.0W
3	179-3	58.5N	151.6W
4	98-3	56.8N	174.8E
5	197-3	56.8N	141.9W
6	122-3	54.9N	167.1W
7	52-3	53.4N	164.7E
8	54-3	52.0N	172.9E
9	27-3	51.7N	158.8E
10	199-3	51.7N	135.6W
11	124-3	51.3N	158.8W
12	164-3	50.9N	145.6W
13	80-3	50.3N	171.3W
14	31-3	49.3N	174.1E
15	216-3	49.0N	128.4W
16	47-2	47.1N	161.2E
17	96-7	45.8N	139.3E
18	147-3	45.6N	144.2W
19	9-3	44.3N	177.7W
20	106-3	44.2N	152.7W
21	202-3	43.7N	128.7W
22	36-3	42.8N	167.5W
23	67-2	42.4N	172.1W
24	168-3	41.0N	134.9W
25	156-7	40.2N	131.2E
26	309-1	39.5N	153.8E
27	188-3	36.2N	127.4W
28	205-3	36.1N	123.8W
29	62-2	35.9N	171.0W
30	109-2	35.7N	176.1E
31	40-3	35.6N	155.2W
32	110-3	35.4N	142.0W
33	285-1	34.6N	145.9E
34	296-1	34.2N	155.1E
35	152-2	34.2N	163.8E
36	207-7	33.7N	123.9E
37	175-4	32.9N	119.4W
38	172-3	31.5N	127.7W
39	127-2	29.9N	177.3W
40	82-2	29.6N	165.0W
41	251-1	29.4N	134.9E
42	91-3	28.6N	139.2W
43	236-1	28.2N	125.9E
44	267-1	27.9N	150.7E
45	44-3	27.8N	145.6W
46	185-2	26.1N	170.8E
47	120-4	25.0N	119.4W
48	55-2	23.5N	151.8W
49	209-1	22.6N	128.0E
50	122-2	21.7N	162.7W
51	181-2	20.5N	177.1W
52	53-4	19.2N	127.8W
53	175-1	18.5N	120.7E
54	231-2	18.2N	168.8E
55	197-1	17.6N	138.5E
56	81-4	17.6N	111.5W

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57	200-1	14.9N	147.9E
58	160-1	14.5N	127.7E
59	158-2	14.0N	160.6W
60	117-1	12.2N	112.6E
61	203-1	12.0N	156.7E
62	27-1	4.1N	106.7E
63	57-1	2.1N	123.6E

Parameterized North Atlantic Grid Points

Seq. Number	Grid Point Subprojection	Latitude	Longitude
1	38-3	67.7N	.4W
2	37-3	66.6N	6.8E
3	62-3	65.7N	5.8W
4	87-3	63.8N	24.1W
5	84-3	62.9N	3.9W
6	107-3	61.1N	14.6W
7	110-3	60.7N	33.1W
8	111-3	60.1N	38.7W
9	129-3	58.6N	24.0W
10	128-3	58.6N	18.2W
11	127-3	58.3N	12.3W
12	132-3	57.2N	40.3W
13	149-3	55.9N	26.7W
14	124-3	55.9N	4.4E
15	147-3	55.8N	15.7W
16	134-3	55.4N	49.3W
17	304-2	52.6N	49.9W
18	171-3	51.5N	42.7W
19	184-3	50.6N	21.5W
20	187-3	50.0N	35.4W
21	182-3	50.0N	11.7W
22	279-2	46.2N	44.9W
23	216-3	45.2N	21.6W
24	218-3	45.1N	30.2W
25	215-3	45.0N	17.3W
26	277-2	44.8N	53.1W
27	214-3	44.6N	12.9W
28	269-2	44.1N	42.1W
29	257-2	41.4N	43.3W
30	247-2	39.8N	33.2W
31	242-3	39.3N	13.9W
32	263-2	38.8N	65.1W
33	243-2	37.9N	48.2W
34	261-2	36.1N	71.8W
35	240-2	35.1N	59.3W
36	220-2	35.0N	29.0W
37	228-2	34.1N	52.9W
38	265-3	33.7N	11.1W
39	216-2	33.4N	43.0W
40	203-2	32.0N	33.7W
41	214-2	31.9N	50.2W
42	222-1	30.4N	77.9W

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43	224-2	29.7N	66.5W
44	287-3	29.7N	18.7W
45	211-2	29.0N	60.5W
46	210-1	28.8N	86.7W
47	182-2	26.7N	48.5W
48	151-2	24.4N	30.9W
49	207-2	24.2N	72.8W
50	226-1	24.0N	89.4W
51	161-2	20.8N	59.1W
52	262-1	19.9N	80.8W
53	127-2	19.2N	44.7W
54	124-2	16.7N	54.2W
55	69-2	15.5N	24.3W
56	139-2	14.7N	68.4W
57	283-1	14.1N	80.8W
58	85-2	14.1N	43.4W
59	81-2	10.8N	55.5W
60	27-4	10.0N	17.2W
61	18-2	9.2N	31.9W
62	75-4	4.7N	20.4W
63	37-4	3.7N	44.0W

6. **How to Order Data**:

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: NCDC.Orders@noaa.gov

7. **Archiving Data Center**:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8. **Technical Contact**:

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9. **Known Uncorrected Problems**: No information provided with original documentation.

10. **Quality Statement**: No information provided with original documentation.

11. **Essential Companion Datasets**: No information provided with original documentation.

12. **References**:

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